Print Media with Embedded Messages for Controlling Printing

Related Application Data

The subject matter of the present application is related to that disclosed in US Patent 5,862,260, and in co-pending application 09/503,881, filed February 14, 2000; which are hereby incorporated by reference.

Technical Field

The invention relates to printer systems, and specifically, relates to adapting printer performance for different types of print media.

Background and Summary

A challenge facing printer manufacturers is developing cost effective ways to optimize printer operation for a variety of different types of paper. The myriad of paper types available today can exhibit widely varying performance in a printer. For example, in the field of ink jet printing, the absorption properties of different types of paper can significantly impact print quality. If the printer could ascertain characteristics of the paper, it could adapt its operation to the absorption properties of the paper and provide a higher quality printing across a variety of paper types.

One way to optimize printer performance for a variety of paper types is to make the printer operating parameters adaptable to a range of paper types. This leads to another challenge of properly setting the operating parameters for a particular print job. One way to set the parameters is to provide a user interface that enables the user to input paper type or paper characteristics. This, of course, is quite demanding on the user.

Another alternative is to automate parameter adjustment by incorporating technology into a printer to enable it to determine paper type automatically and adapt its operation accordingly. For example, developers of ink jet printing technology have attempted to design sensors to determine paper type so that printer operation can be

optimized for the paper. Ideally, the printer should be able to detect paper characteristics such as its thickness, reflectivity, dimensions, absorption coefficient, and bleeding coefficient. While such sensor technology holds promise in improving print quality, building such sophisticated sensor technology is complex and costly.

The invention provides technology for determining print media attributes and adjusting printer parameters using control data embedded in the print media. In particular, a message embedded in the printer paper conveys printer control information to the printer about paper characteristics. A printer, or other system with printing capability (e.g., fax machine, scanner, copier, etc.) uses a sensor to capture a representation of the message signal and automatically decodes printer control information from the message signal. A control unit in the printer interprets this information and uses it to adjust operation of the printer.

There are several aspects to the invention. One aspect of the invention is a paper medium carrying a steganographic message used to adapt printer operation to the paper medium. The steganographic message includes printer control information related to the paper medium that is readable by a machine. This information is used to control a printer so as to optimize print quality for the paper medium.

Another aspect of the invention is a printer system that adapts the operation of a printer to print media based on control information embedded in the print media. The system comprising an image sensor for capturing an image of print media, a steganographic decoder for reading a steganoraphic message from the image of the print media, and a printer control unit in communication with the decoder. The printer control unit receives the printer control information and uses the information to optimize printer operation for the print media.

Another aspect of the invention is a method for adapting operation of a printer to a type of print media. The method captures an image of at least a portion of a print media, steganographically decodes a message from the image, including printer control information, and uses the printer control information to adapt operation of the printer to the type of print media.

Further features will become apparent with reference to the following detailed description and accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a block diagram illustrating a printer architecture that reads digital watermarks to obtain printer control information.

Detailed Description

The following sections describe methods and systems for using digital watermarks on print media to convey printer control information to a printer. This printer control information may be expressed in many forms. It encompasses paper characteristics and printer control parameters. One form of printer control information is an identifier or set of identifiers that index control information. The printer uses the identifiers to look up corresponding printer operating parameters.

Another form of control information is a set of paper characteristics, such as paper thickness, reflectivity, dimensions, absorption coefficients, bleeding coefficients, etc. Still another form of control information is one or more printer control parameters that control printer operating settings. In an ink jet printer, these settings may include the volume of ink drops, the number of ink drops emitted per unit area, etc. It may also include rendering of the image at the optimum resolution (e.g., dpi) determined by the control information embedded in the paper.

Fig. 1 is a block diagram illustrating a printer architecture that reads digital watermarks to obtain printer control information. The watermarked print media 100 shown in Fig. 1 represents a sheet of paper or other object submitted to the printer. The print media includes a digital watermark that conveys printer control information. A variety of digital watermarking schemes may be used to embed the watermark onto the

print media. Some example watermark encoding and decoding schemes are provided in US Patent 5,862,260, and in co-pending application 09/503,881, filed February 14, 2000.

In digital watermarking of physical objects, there is a tradeoff between visual perceptibility and survivability of the watermark. In this application, the watermark is embedded so as to be sufficiently robust to survive analog to digital conversion. The watermark may be encoded by altering the luminance or one or more other color channels of an image on the surface of the paper. Alternatively, the watermark may be encoded using clear inks that modulate the microtopology of the paper's surface or that are readable when exposed to light in non-visible wavelengths, like UV or infrared. Also, the microtopology of the paper surface may be altered in the process of creating the paper so as to embed a watermark. Alternative machine readable codes may be used as well, such as data glyphs, bar codes, etc.

The watermark signal is preferably repeated on the surface of the print media so that a watermark decoder can extract the printer control information from a small and relatively arbitrary portion of the print media. For example, the watermark signal may be repeated across one side or both sides of a piece of paper. If the watermark is slightly visible like a conventional watermark, it may be preferable to place it only on one side of the paper so as not to interfere with content printed on the other side.

In the system depicted in Fig. 1, the printer architecture has an image sensor102 to capture an image of the watermarked print media. As discussed below, the image sensor may be an integrated component of a product with a printer subsystem or a separate component of a computer system attached to a printer. The image sensor transfers the image to a memory device. Depending on the implementation, this transfer may encompass one or more intermediate stages where portions of the image are temporarily buffered, transformed (e.g., color conversion), compressed, uncompressed.

A watermark decoder 104 reads watermarked image data from the memory device, detects the watermark in the watermarked image and extracts a message from the watermark, including any printer control information. The decoder communicates the printer control information to a printer control unit 106, which in turn, interprets the

control information and determines the corresponding operating parameters 108 to apply to a print job for the print media.

The printer control unit 106 enforces these operating parameters by issuing corresponding control signals to a print mechanism 110.

The image sensor, watermark decoder and printer control may be implemented in a variety of combinations of hardware, firmware and software.

The image sensor may be implemented using conventional imaging devices such as CCD or CMOS arrays used in scanners and cameras. The sensor may be built into the printer, or may be a peripheral device, such as a PC camera. In the former case, the image sensor within the printer communicates image data to the watermark decoder. Many printers are subsystems of multifunction devices that have printing and scanning functions. For example, copiers and fax machines have printers, image sensors, and memory for storing an images or portions of an image. In these types of devices, the watermark decoder operates on portions of the image as it is scanned into the device's image memory.

In the latter case, the image sensor may communicate the watermarked image directly to an image memory and watermark decoder within the printer. Alternatively, the image sensor may communicate the image to image memory in a computer, which in turn, either executes a software watermark decoder on the image, or transfers the image to a watermark decoder in the printer. For example, a printer driver executing on a PC attached to the printer may include a watermark decoder to extract printer control information. In this configuration, a user would present the paper to a camera, such as a PC camera, attached to the computer. The printer driver then would access image data in the computer's memory captured from the camera and execute watermark detecting and reading on that image data. The printer driver then either communicates extracted printer control information to the printer, or interprets it on the PC and issues control signals to the printer.

As demonstrated in the examples provided above, the watermark decoder may be implemented within a printer or in a separate device that communicates the printer

control information or control signals to the printer. For example, the watermark decoder may be an application program (e.g., the printer driver program) in a computer attached to a printer, or a program implemented in software or firmware in the printer. Alternatively, the watermark decoder may be implemented in hardware within the printer or some other device connected to it, such as a camera, Personal Computer, personal digital assistant, etc.

The printer control unit may be implemented within the printer, a device connected to the printer, or in a combination of both. For example, the control unit may be a programmed processor, such as a DSP, in the printer, a printer driver in a computer attached to the printer, or in a combination of both.

To illustrate the operation of the system, consider an example of a multifunction device that includes an ink jet printer and scanner. The user places blank watermarked paper in the printer and sends a print job to the printer from an attached computer. As the printer loads a sheet of paper to start the print job, it scans an image of at least a portion of it (e.g., the top edge). When sufficient image data fills a buffer in the scanning subsystem, it sends a signal to the watermark decoder, executing within a processing unit on the device. The amount of image data needed to trigger watermark decoding depends in part on the embedding process, and specifically, on the minimum image size required to hold a complete watermark message. For example, if the watermark is repeated in lines or blocks of the paper surface, the image sensor needs to capture an image of at least one line or block.

Operating on the image data, the watermark decoder detects the watermark, reads the message from it, and transfers the printer control information in the message to the printer control unit.. The printer control unit uses the printer control information as an index in a table to look up corresponding operating parameters. These operating parameters are associated with control signals. The printer control unit issues these control signals to the print mechanism. The print mechanism includes a print head and cartridge that allows for the control of ink drops per a given dot location on the page. Based on the absorption properties of the paper, as conveyed in the watermark, the printer

control unit sends a control signal to the printer cartridge that specifies the number of drops to be emitted per dot.

These functions of the printer control unit may be implemented within the same or separate processing unit as the one that executes the watermark decoder.

Concluding Remarks

Having described and illustrated the principles of the technology with reference to specific implementations, it will be recognized that the technology can be implemented in many other, different, forms. To provide a comprehensive disclosure without unduly lengthening the specification, applicants incorporate by reference the patents and patent applications referenced above.

The particular combinations of elements and features in the above-detailed embodiments are exemplary only; the interchanging and substitution of these teachings with other teachings in this and the incorporated-by-reference patents/applications are also contemplated.